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Fuse Technology

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Circuit Protection

Electrical distribution systems are often quite complicated. They cannot be absolutely fail-safe. Circuits are subject to destructive overcurrents. Harsh environments, general deterioration, accidental damage, damage from natural causes, excessive expansion, and/or overloading of the electrical distribution system are factors which contribute to the occurrence of such overcurrents. Reliable protective devices prevent or minimize costly damage to transformers, conductors, motors, and the other many components and loads that make up the complete distribution system. Reliable circuit protection is essential to avoid the severe monetary losses which can result from power blackouts and prolonged downtime of facilities. It is the need for reliable protection, safety, and freedom from fire hazards that has made the fuse a widely used protective device.

Overcurrents

An overcurrent is either an overload current or a short-circuit current. The overload current is an excessive current relative to normal operating current, but one which is confined to the normal conductive paths provided by the conductors and other components and loads of the distribution system. As the name implies, a short-circuit current is one which flows outside the normal conducting paths.

Overloads

Overloads are most often between one and six times the normal current level. Usually, they are caused by harmless temporary surge currents that occur when motors are started-up or transformers are energized. Such overload currents, or transients, are normal occurrences. Since they are of brief duration, any temperature rise is trivial and has no harmful effect on the circuit components. (It is important that protective devices do not react to them.)

Continuous overloads can result from defective motors (such as worn motor bearings), overloaded equipment, or too many loads on one circuit. Such sustained overloads are destructive and must be cut off by protective devices before they damage the distribution system or system loads. However, since they are of relatively low magnitude compared to short-circuit currents, removal of the overload current within minutes will generally prevent equipment damage. A sustained overload current results in overheating of conductors and other components and will cause deterioration of insulation, which may eventually result in severe damage and short-circuits if not interrupted.

Short-Circuits

Whereas overload currents occur at rather modest levels, the short-circuit or fault current can be many hundred times larger than the normal operating current. A high level fault may be 50,000 amperes (or larger). If not cut off within a matter of a few thousandths of a second, damage and destruction can become rampant—there can be severe insulation damage, melting of conductors, vaporization of metal, ionization of gases, arcing, and fires. Simultaneously, high level short-circuit currents can develop huge magnetic-field stresses. The magnetic forces between bus bars and other conductors can be many hundreds of pounds per linear foot; even heavy bracing may not be adequate to keep them from being warped or distorted beyond repair.

Fuses

The fuse is a reliable overcurrent protective device. A "fusible" link or links encapsulated in a tube and connected to contact terminals comprise the fundamental elements of the basic fuse. Electrical resistance of the link is so low that it simply acts as a conductor. However, when destructive currents occur, the link very quickly melts and opens the circuit to protect conductors and other circuit components and loads. Fuse characteristics are stable. Fuses do not require periodic maintenance or testing. Fuses have three unique performance characteristics:

1. **Modern fuses have an extremely "high interrupting rating"—can withstand very high fault currents without rupturing.**
2. **Properly applied, fuses prevent "blackouts." Only the fuse nearest a fault opens without upstream fuses (feeders or mains) being affected—fuses thus provide "selective coordination." (These terms are precisely defined in subsequent pages.)**
3. **Fuses provide optimum component protection by keeping fault currents to a low value…They are said to be "current limiting."**

Voltage Rating

The voltage rating of a fuse must be at least equal to or greater than the circuit voltage. It can be higher but never lower. For instance, a 600 volt fuse can be used in a 208 volt circuit.

The voltage rating of a fuse is a function of its capability to open a circuit under an overcurrent condition. Specifically, the voltage rating determines the ability of the fuse to suppress the internal arcing that occurs after a fuse link melts and an arc is produced. If a fuse is used with a voltage rating lower than the circuit voltage, arc suppression will be impaired and, under some fault current conditions, the fuse may not clear the overcurrent safely. Special consideration is necessary for semiconductor fuse and medium voltage fuse applications, where a fuse of a certain voltage rating is used on a lower voltage circuit.

Ampere Rating

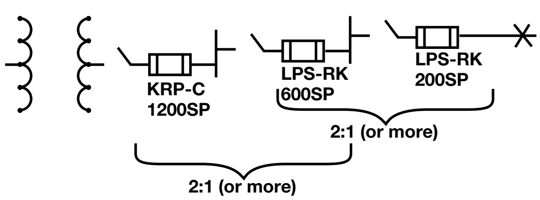
Every fuse has a specific ampere rating. In selecting the ampere rating of a fuse, consideration must be given to the type of load and code requirements. The ampere rating of a fuse normally should not exceed the current carrying capacity of the circuit. For instance, if a conductor is rated to carry 20 amperes, a 20 ampere fuse is the largest that should be used. However, there are some specific circumstances in which the ampere rating is permitted to be greater than the current carrying capacity of the circuit. A typical example is the motor circuit; dual-element fuses generally are permitted to be sized up to 175% and non-time-delay fuses up to 300% of the motor full-load amperes. As a rule, the ampere rating of a fuse and switch combination should be selected at 125% of the continuous load current (this usually corresponds to the circuit capacity, which is also selected at 125% of the load current). There are exceptions, such as when the fuse-switch combination is approved for continuous operation at 100% of its rating.

Interrupting Rating

A protective device must be able to withstand the destructive energy of short-circuit currents. If a fault current exceeds the capability of the protective device, the device may actually rupture, causing additional damage. Thus, it is important when applying a fuse or circuit breaker to use one which can sustain the largest potential short-circuit currents. The rating which defines the capacity of a protective device to maintain its integrity when reacting to fault currents is termed its "interrupting rating". The interrupting rating of most branch-circuit, molded case, circuit breakers typically used in residential service entrance panels is 10,000 amperes. (Please note that a molded case circuit breaker's interrupting capacity will typically be lower than its interrupting rating.) Larger, more expensive circuit breakers may have interrupting ratings of 14,000 amperes or higher. In contrast, most modern, current-limiting fuses have an interrupting rating of 200,000 or 300,000 amperes and are commonly used to protect the lower rated circuit breakers. The National Electrical Code, Section 110-9, requires equipment intended to break current at fault levels to have an interrupting rating sufficient for the current that must be interrupted.

Selective Coordination – Prevention of Blackouts

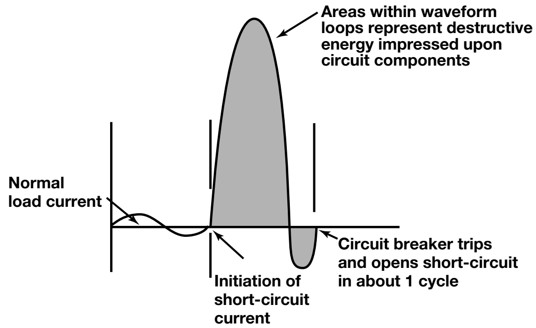
The coordination of protective devices prevents system power outages or blackouts caused by overcurrent conditions. When only the protective device nearest a faulted circuit opens and larger upstream fuses remain closed, the protective devices are "selectively" coordinated (they discriminate). The word "selective" is used to denote total coordination…isolation of a faulted circuit by the opening of only the localized protective device.



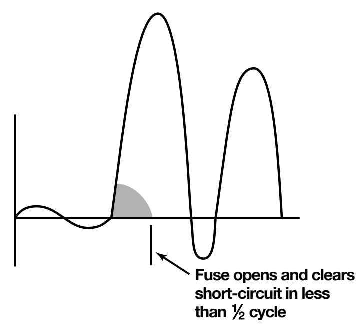
This diagram shows the minimum ratios of ampere ratings of LOW-PEAK YELLOW fuses that are required to provide "selective coordination" (discrimination) of upstream and downstream fuses.

Unlike electro-mechanical inertial devices (circuit breakers), it is a simple matter to selectively coordinate fuses of modern design. By maintaining a minimum ratio of fuse-ampere ratings between an upstream and downstream fuse, selective coordination is assured.

Current Limitation – Component Protection



A non-current-limiting protective device, by permitting a short-circuit current to build up to its full value, can let an immense amount of destructive short-circuit heat energy through before opening the circuit.



A current-limiting fuse has such a high speed of response that it cuts off a short-circuit long before it can build up to its full peak value.

If a protective device cuts off a short-circuit current in less than one-quarter cycle, before it reaches its total available (and highly destructive) value, the device is a "current-limiting" device. Most modern fuses are current-limiting. They restrict fault currents to such low values that a high degree of protection is given to circuit components against even very high short-circuit currents. They permit breakers with lower interrupting ratings to be used. They can reduce bracing of bus structures. They minimize the need of other components to have high short-circuit current "withstand" ratings. If not limited, short-circuit currents can reach levels of 30,000 or 40,000 amperes or higher in the first half cycle (.008 seconds, 60 hz) after the start of a short-circuit. The heat that can be produced in circuit components by the immense energy of short-circuit currents can cause severe insulation damage or even explosion. At the same time, huge magnetic forces developed between conductors can crack insulators and distort and destroy bracing structures. Thus, it is important that a protective device limit fault currents before they reach their full potential level.

Operating Principles of Bussmann® Fuses

The principles of operation of the modern, current-limiting Buss fuses are covered in the following paragraphs.

Non-Time-Delay Fuses

The basic component of a fuse is the link. Depending upon the ampere rating of the fuse, the single-element fuse may have one or more links. They are electrically connected to the end blades (or ferrules) (see Figure 1) and enclosed in a tube or cartridge surrounded by an arc quenching filler material. BUSS® LIMITRON® and T-TRON® fuses are both single-element fuses.

Under normal operation, when the fuse is operating at or near its ampere rating, it simply functions as a conductor. However, as illustrated in Figure 2, if an overload current occurs and persists for more than a short interval of time, the temperature of the link eventually reaches a level which causes a restricted segment of the link to melt. As a result, a gap is formed and an electric arc established. However, as the arc causes the link metal to burn back, the gap becomes progressively larger. Electrical resistance of the arc eventually reaches such a high level that the arc cannot be sustained and is extinguished. The fuse will have then completely cut off all current flow in the circuit. Suppression or quenching of the arc is accelerated by the filler material. (See Figure 3.)

Single-element fuses of present day design have a very high speed of response to overcurrents. They provide excellent short-circuit component protection. However, temporary, harmless overloads or surge currents may cause nuisance openings unless these fuses are oversized. They are best used, therefore, in circuits not subject to heavy transient surge currents and the temporary over-load of circuits with inductive loads such as motors, transformers, solenoids, etc. Because single-element, fast-acting fuses such as LIMITRON and T-TRON fuses have a high speed of response to short-circuit currents, they are particularly suited for the protection of circuit breakers with low interrupting ratings.

Whereas an overload current normally falls between one and six times normal current, short-circuit currents are quite high. The fuse may be subjected to short-circuit currents of 30,000 or 40,000 amperes or higher. Response of current limiting fuses to such currents is extremely fast. The restricted sections of the fuse link will simultaneously melt (within a matter of two or three-thousandths of a second in the event of a high-level fault current).

The high total resistance of the multiple arcs, together with the quenching effects of the filler particles, results in rapid arc suppression and clearing of the circuit. (Refer to Figures 4 & 5) Short-circuit current is cut off in less than a half-cycle, long before the short-circuit current can reach its full value (fuse operating in its current limiting range).

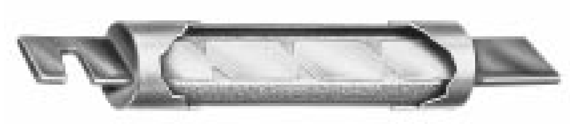


Figure 1. Cutaway view of typical single-element fuse.

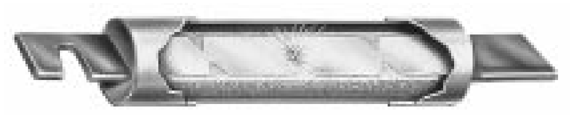


Figure 2. Under sustained overload, a section of the link melts and an arc is established.

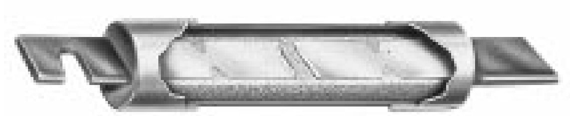


Figure 3. The “open” single-element fuse after opening a circuit overload.

Figure 4. When subjected to a short-circuit current, several sections of the fuse link melt almost instantly.

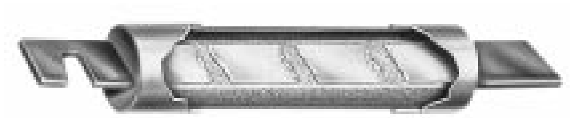


Figure 5. The “open” single-element fuse after opening a short circuit.

Dual-Element, Time-Delay Fuses as Manufactured by Bussmann

Unlike single-element fuses, the dual-element, time-delay fuse can be applied in circuits subject to temporary motor overloads and surge currents to provide both high performance short-circuit and overload protection. Oversizing in order to prevent nuisance openings is not necessary. The dual-element, time-delay fuse contains two distinctly separate types of elements (Figure 6). Electrically, the two elements are series connected. The fuse links similar to those used in the non-time-delay fuse perform the short-circuit protection function; the overload element provides protection against low-level overcurrents or overloads and will hold an overload which is five times greater than the ampere rating of the fuse for a minimum time of 10 seconds.

As shown in Figure 6, the overload section consists of a copper heat absorber and a spring operated trigger assembly. The heat absorber bar is permanently connected to the heat absorber extension (left end of illustration) and to the short-circuit link on the opposite end of the fuse by the "S"-shaped connector of the trigger assembly. The connector electrically joins the short-circuit link to the heat absorber in the overload section of the fuse. These elements are joined by a "calibrated" fusing alloy. As depicted in Figure 7, an overload current causes heating of the short-circuit link connected to the trigger assembly. Transfer of heat from the short-circuit link to the heat absorbing bar in the mid-section of the fuse begins to raise the temperature of the heat absorber. If the overload is sustained, the temperature of the heat absorber eventually reaches a level which permits the trigger spring to "fracture" the calibrated fusing alloy and pull the connector free of the short-circuit link and the heat absorber. As a result, the short-circuit link is electrically disconnected from the heat absorber, the conducting path through the fuse is opened, and overload current is interrupted (See Figure 8.). A critical aspect of the fusing alloy is that it retains its original characteristic after repeated temporary overloads without degradation. When subjected to a short circuit current, the restricted sections of the short-circuit link will simultaneously melt (within a matter of two or three-thousandths of a second in the event of a high-level fault current). The high total resistance of the multiple arcs, together with the quenching effects of the filler particles, results in rapid arc suppression and clearing of the circuit. (Refer to Figures 9 & 10.)

BUSS dual-element fuses, typically LOW-PEAK YELLOW™ and FUSETRON® fuses, utilize the spring-loaded design in the overload element.

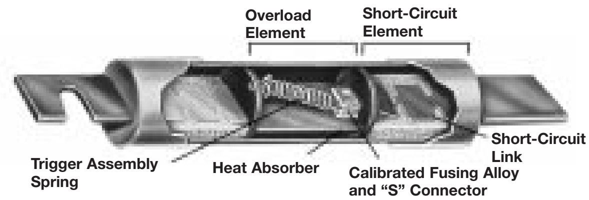


Figure 6. The true dual-element fuse has distinct and separate overload and short-circuit elements.

Figure 7. Under sustained overload conditions, the trigger spring fractures the calibrated fusing alloy and releases the "connector".

Figure 8. The "open" dual-element fuse after opening under an overload condition.

Figure 9. Like the single element fuse, a short-circuit current causes the restricted portions of the short-circuit elements to melt. Arcing to burn back the resulting gaps occurs until the arcs are suppressed by the arc quenching material and the increased arc resistance.

Figure 10. The "open" dual-element fuse after opening under a short-circuit condition.

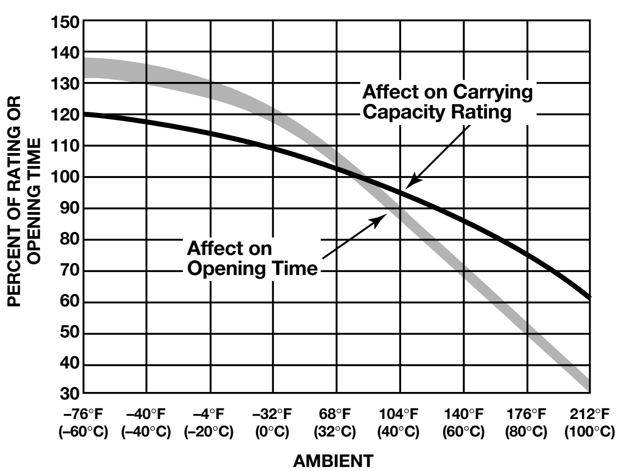
Fuse Time-Current Curves

When a low level overcurrent occurs, a long interval of time will be required for a fuse to open (melt) and clear the fault. On the other hand, if the overcurrent is large, the fuse will open very quickly. The opening time is a function of the magnitude of the level of overcurrent. Overcurrent levels and the corresponding intervals of opening times are logarithmically plotted in graph form as shown to the right. Levels of overcurrent are scaled on the horizontal axis; time intervals on the vertical axis. The curve is thus called a "time-current" curve.

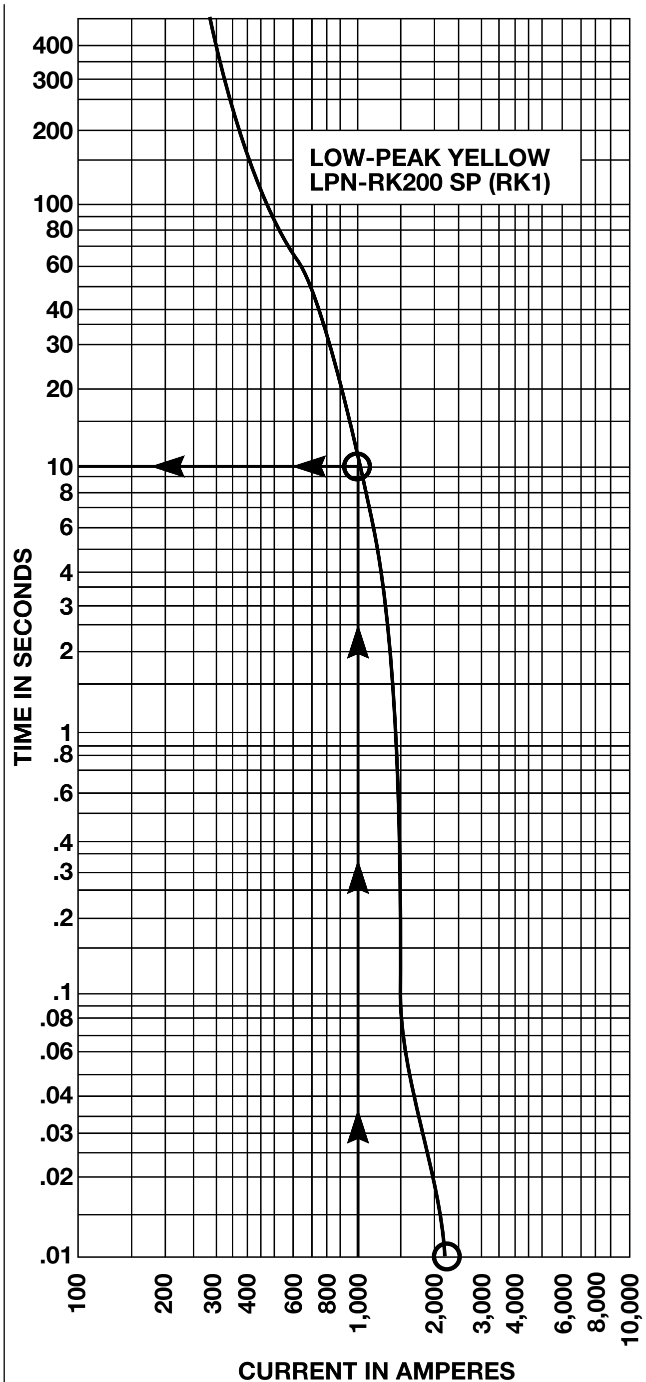
This particular plot reflects the characteristics of a 200 ampere, 250 volt, LOW-PEAK YELLOW dual-element fuse. Note that at the 1,000 ampere overload level, the time interval which is required for the fuse to open is 10 seconds. Yet, at approximately the 2,200 ampere overcurrent level, the opening (melt) time of a fuse is only 0.01 seconds. It is apparent that the time intervals become shorter as the overcurrent levels become larger. This relationship is termed an inverse time-to-current characteristic. Time-current curves are published or are available on most commonly used fuses showing "minimum melt," "average melt" and/or "total clear" characteristics. Although upstream and downstream fuses are easily coordinated by adhering to simple ampere ratios, these time-current curves permit close or critical analysis of coordination.

Better Motor Protection in Elevated Ambients

The derating of dual-element fuses based on increased ambient temperatures closely parallels the derating curve of motors in elevated ambient. This unique feature allows for optimum protection of motors, even in high temperatures.



Affect of ambient temperature on operating characteristics of FUSETRON and LOW-PEAK YELLOW Dual-Element Fuses.



Better Protection Against Motor Single Phasing

When secondary single-phasing occurs, the current in the remaining phases increases to approximately 200% rated full load current. (Theoretically 173%, but change in efficiency and power factor make it about 200%.) When primary single-phasing occurs, unbalanced voltages occur on the motor circuit causing currents to rise to 115%, and 230% of normal running currents in delta-wye systems.

Dual-element fuses sized for motor running overload protection will help to protect motors against the possible damages of single-phasing.

Classes of Fuses

Safety is the industry mandate. However, proper selection, overall functional performance and reliability of a product are factors which are not within the basic scope of listing agency activities. In order to develop its safety test procedures, listing agencies develop basic performance and physical specifications or standards for a product. In the case of fuses, these standards have culminated in the establishment of distinct classes of low-voltage (600 volts or less) fuses; classes RK1, RK5, G, L, T, J, H and CC being the more important.

The fact that a particular type of fuse has, for instance, a classification of RK1, does not signify that it has the identical function or performance characteristics as other RK1 fuses. In fact, the LIMITRON® non-time-delay fuse and the LOW-PEAK YELLOW™ dual-element, time-delay fuse are both classified as RK1. Substantial differences in these two RK1 fuses usually requires considerable difference in sizing. Dimensional specifications of each class of fuse does serve as a uniform standard.

Class R Fuses

Class R ("R" for rejection) fuses are high performance, $\frac{1}{10}$ to 600 ampere units, 250 volt and 600 volt, having a high degree of current limitation and a short-circuit interrupting rating of up to 300,000 amperes (rms symmetrical). BUSS Class R's include Classes RK1 LOW-PEAK YELLOW™ and LIMITRON® fuses, and RK5 FUSETRON® fuses. They have replaced BUSS K1 LOW-PEAK and LIMITRON fuses and K5 FUSETRON fuses. These fuses are identical, with the exception of a modification in the mounting configuration called a "rejection feature". This feature permits Class R fuses to be mounted in rejection type fuseclips. "R" type fuseclips prevent older type Class H, ONE-TIME and RENEWABLE fuses from being installed. The use of Class R fuseholders is thus an important safeguard. The application of Class R fuses in such equipment as disconnect switches permits the equipment to have a high interrupting rating. NEC Articles 110-9 and 230-65 require that protective devices have adequate capacity to interrupt short-circuit currents. Article 240-60(b) requires fuseholders for current-limiting fuses to reject non-current-limiting type fuses.

In the above illustration, a grooved ring in one ferrule provides the rejection feature of the Class R fuse in contrast to the lower interrupting rating, non-rejection type.

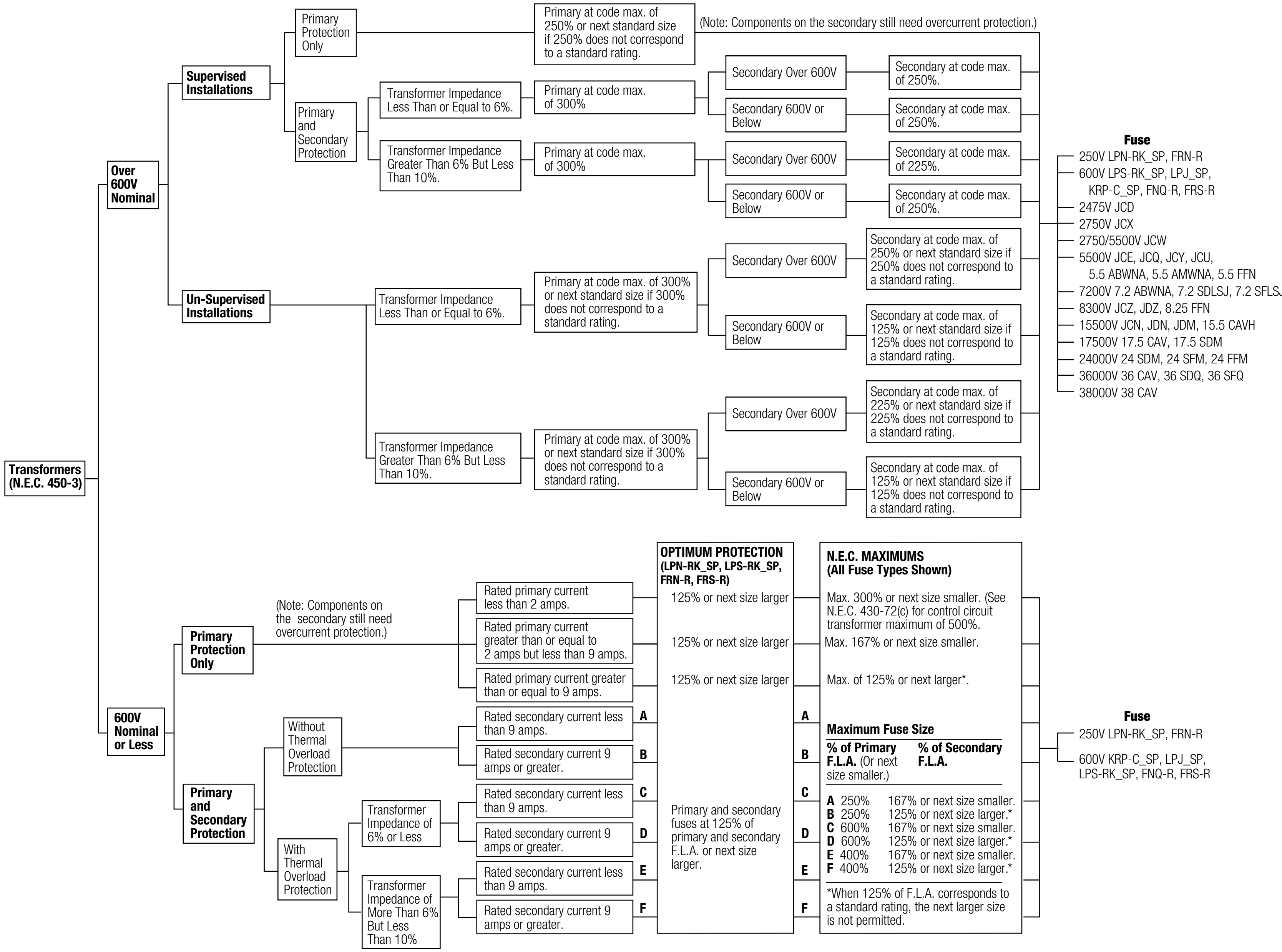
Branch-Circuit Listed Fuses

Branch-circuit listed fuses are designed to prevent the installation of fuses that cannot provide a comparable level of protection to equipment.

The characteristics of Branch-circuit fuses are:

1. They must have a minimum interrupting rating of 10,000 amps.
2. They must have a minimum voltage rating of 125 volts.
3. They must be size rejecting such that a fuse of a lower voltage rating cannot be installed in the circuit.
4. They must be size rejecting such that a fuse with a current rating higher than the fuseholder rating cannot be installed.

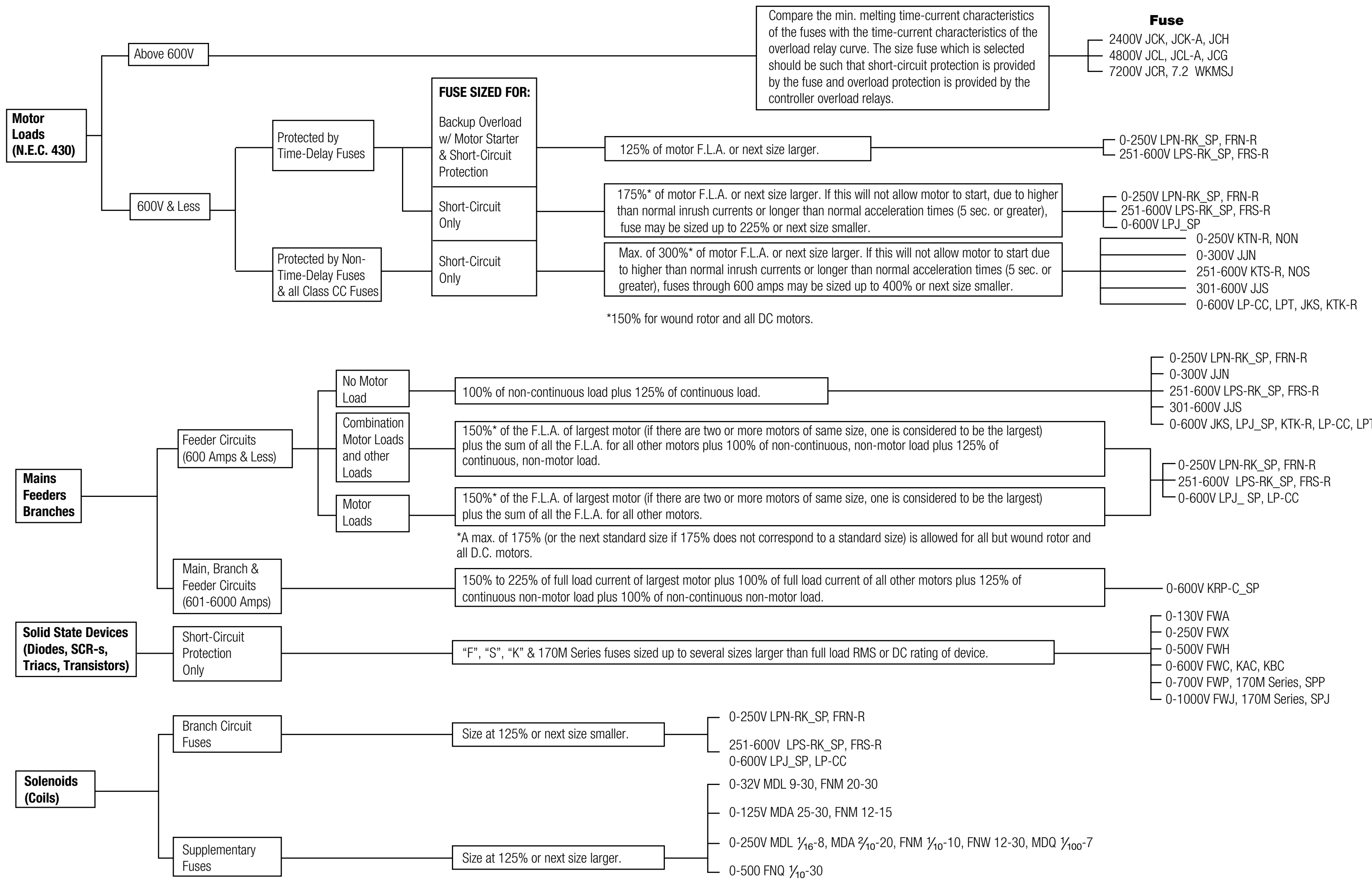
Fuse Diagnostic Chart



Based on 1996 N.E.C.®

Bussmann®

Fuse Diagnostic Chart



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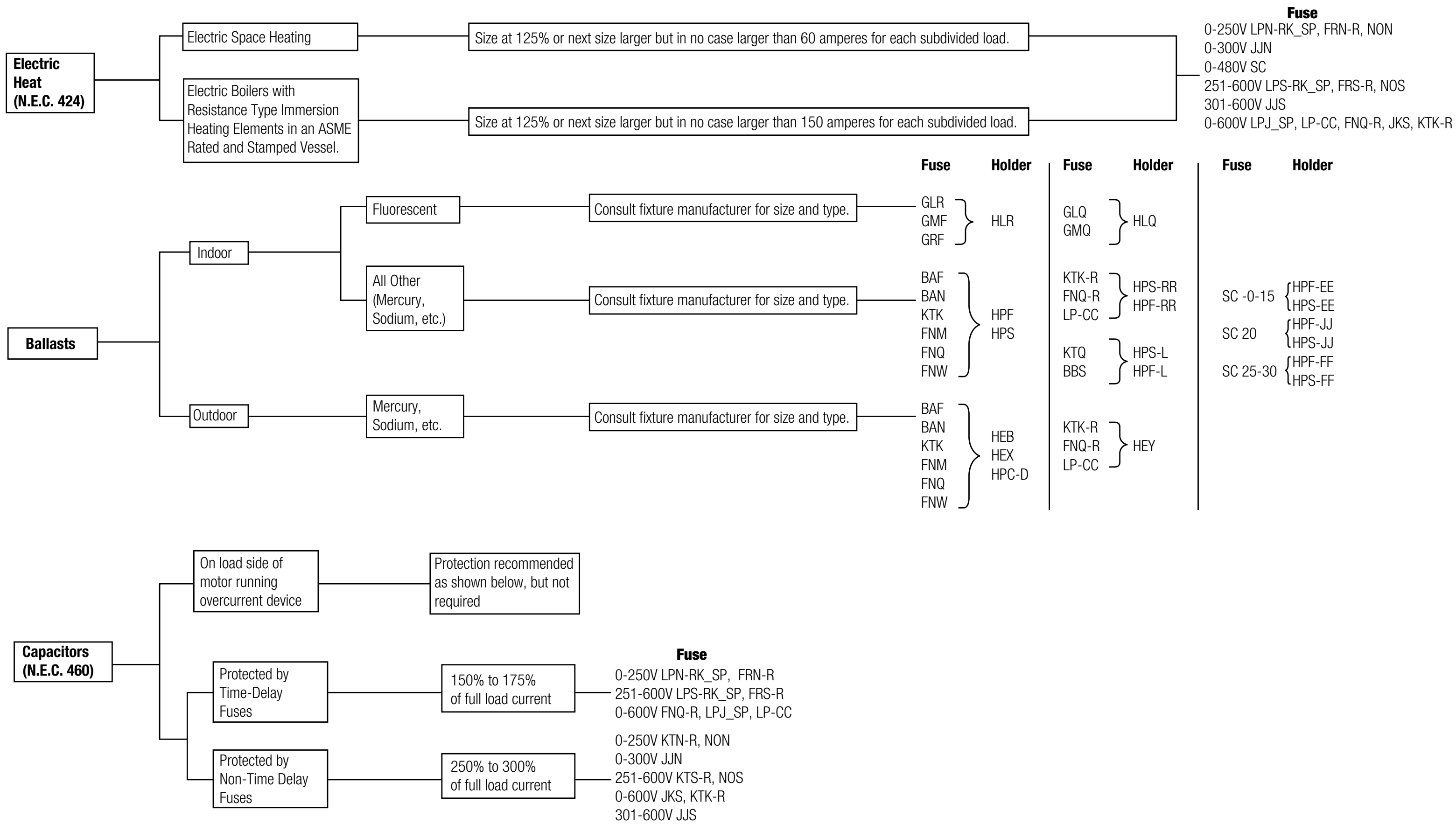

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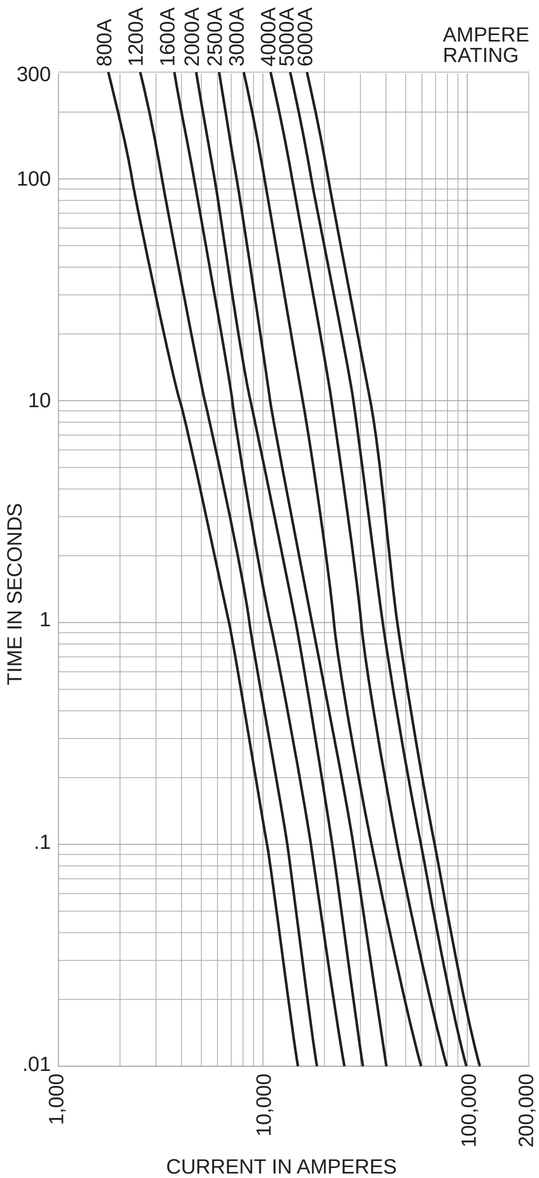
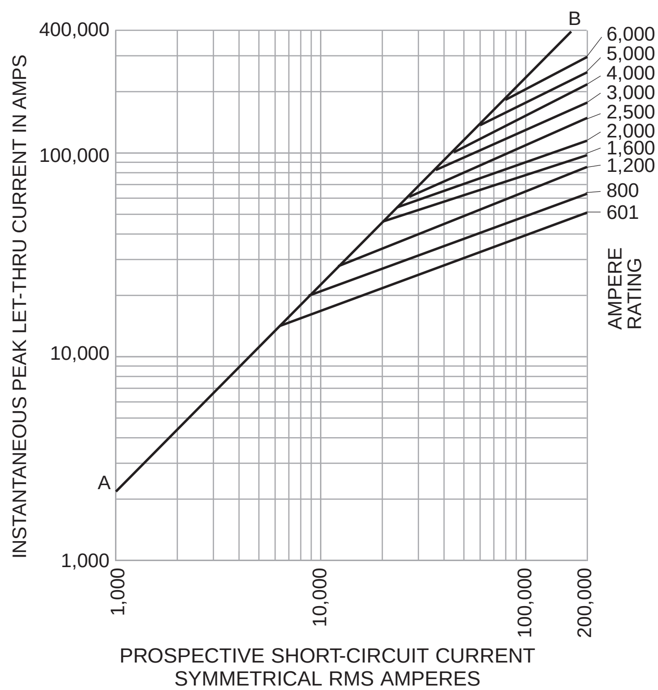
KRP-C, Class L Fuses

KRP-C Time-Current Characteristic Curves—Average Melt

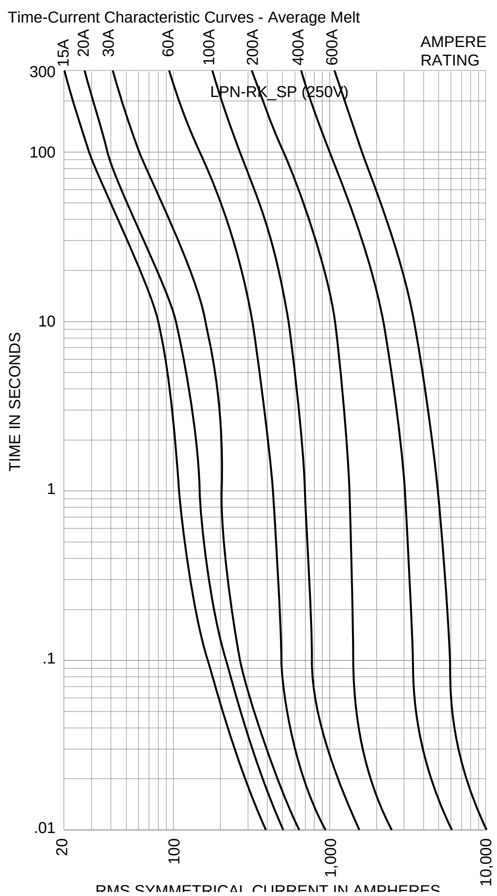


KRP-C Current Limitation Curves

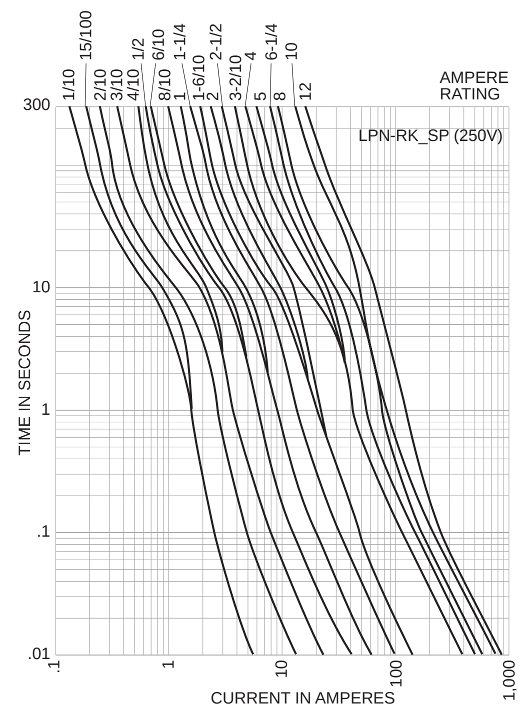


LPN-RK (250V) Class RK1 Fuses

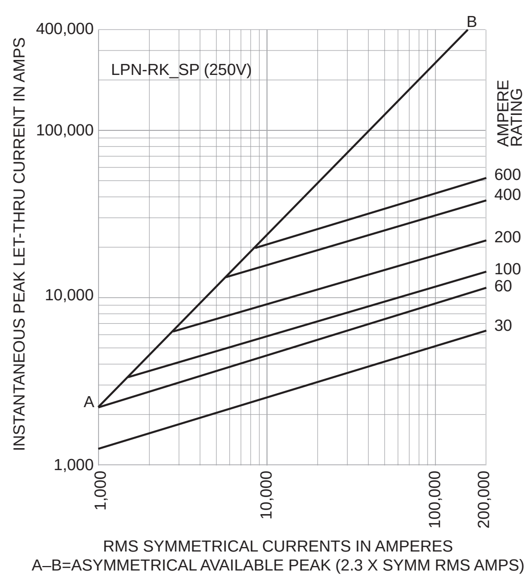
Time-Current Characteristic Curves—Average Melt



Time-Current Characteristic Curves—Average Melt



Current Limitation Curves



LPS-RK (600V) Class RK1 Fuses

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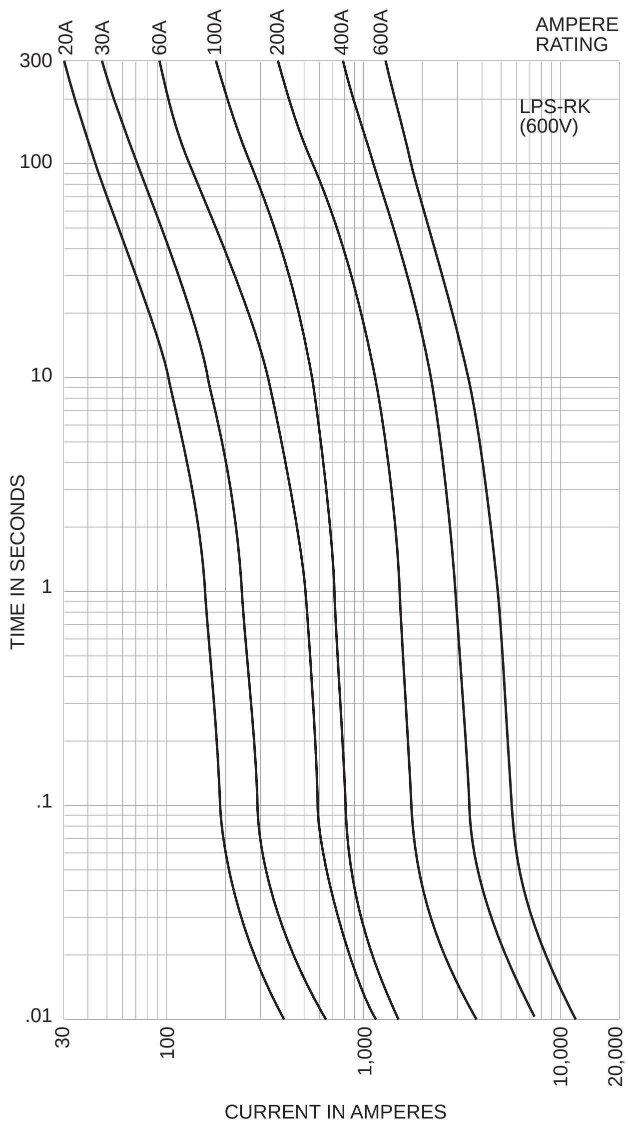
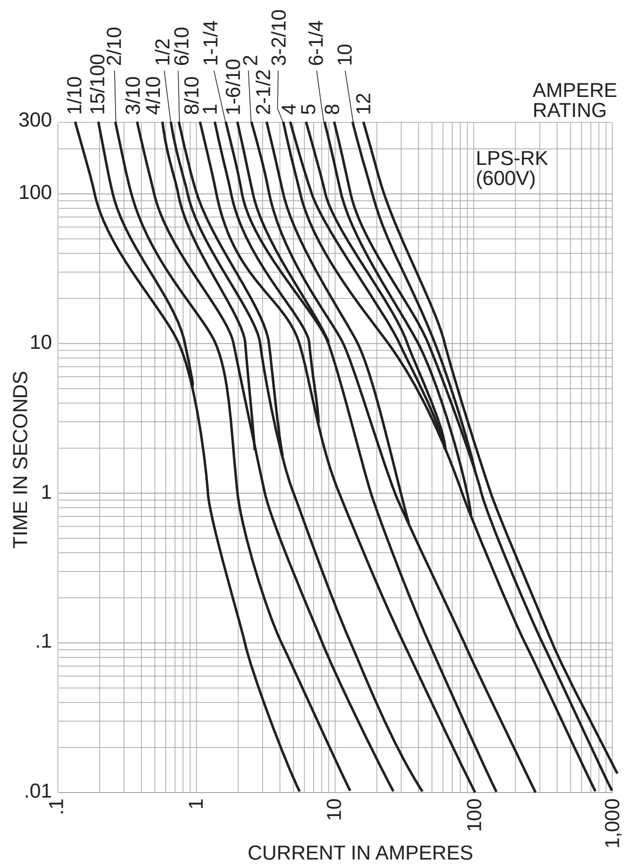
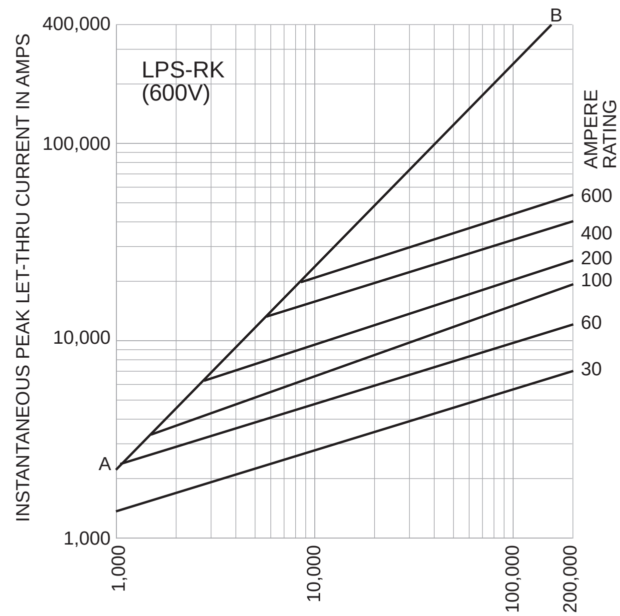


Time-Current Characteristic Curves—Average Melt

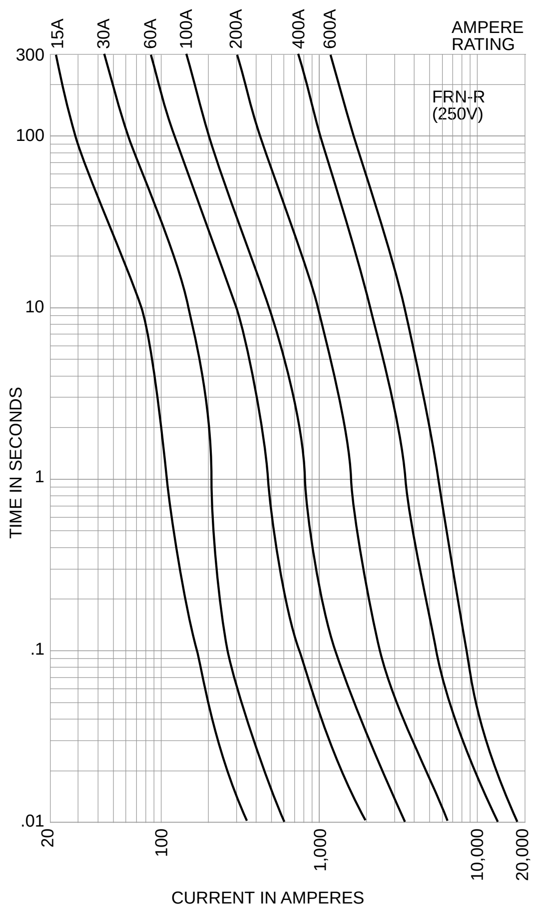


Current Limitation Curves

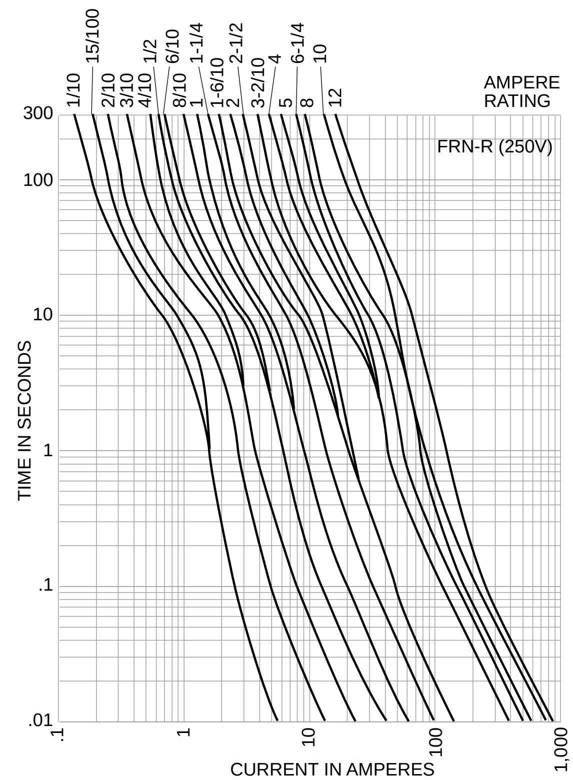


FRN-R (250V) Class RK5 Fuses

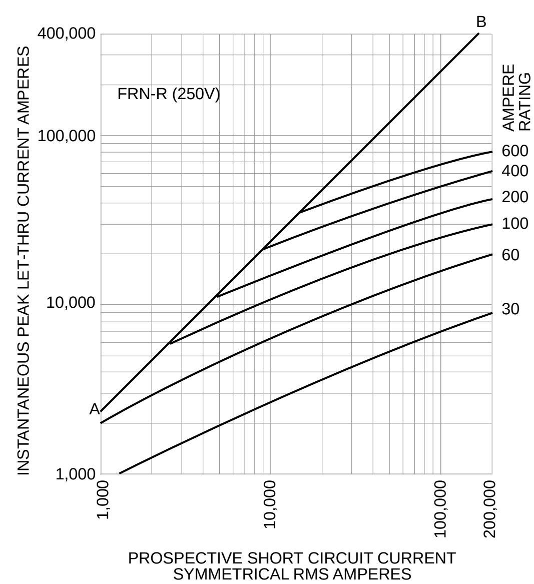
Time-Current Characteristic Curves—Average Melt



Time-Current Characteristic Curves—Average Melt

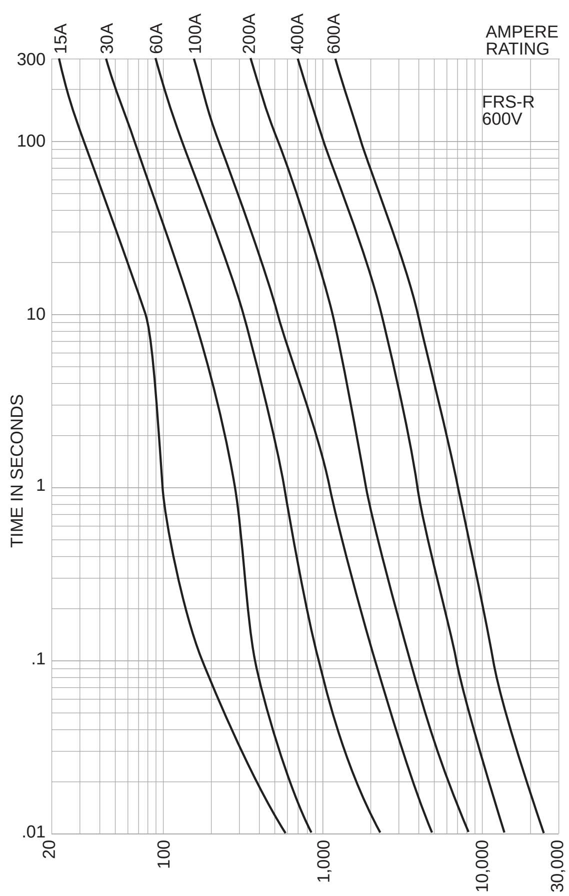


Current Limitation Curves

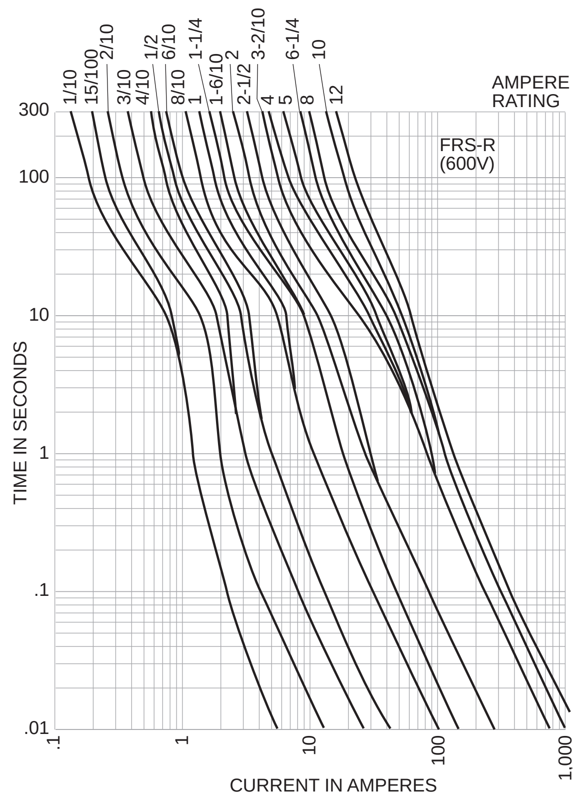


FRS-R (600V) Class RK5 Fuses

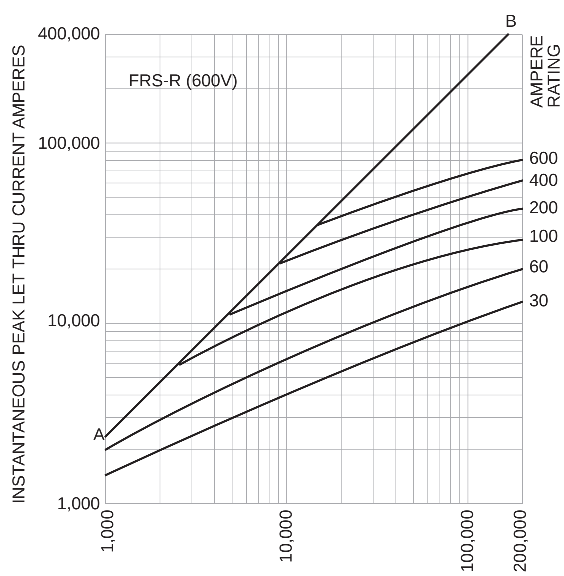
Time-Current Characteristic Curves—Average Melt



Time-Current Characteristic Curves—Average Melt

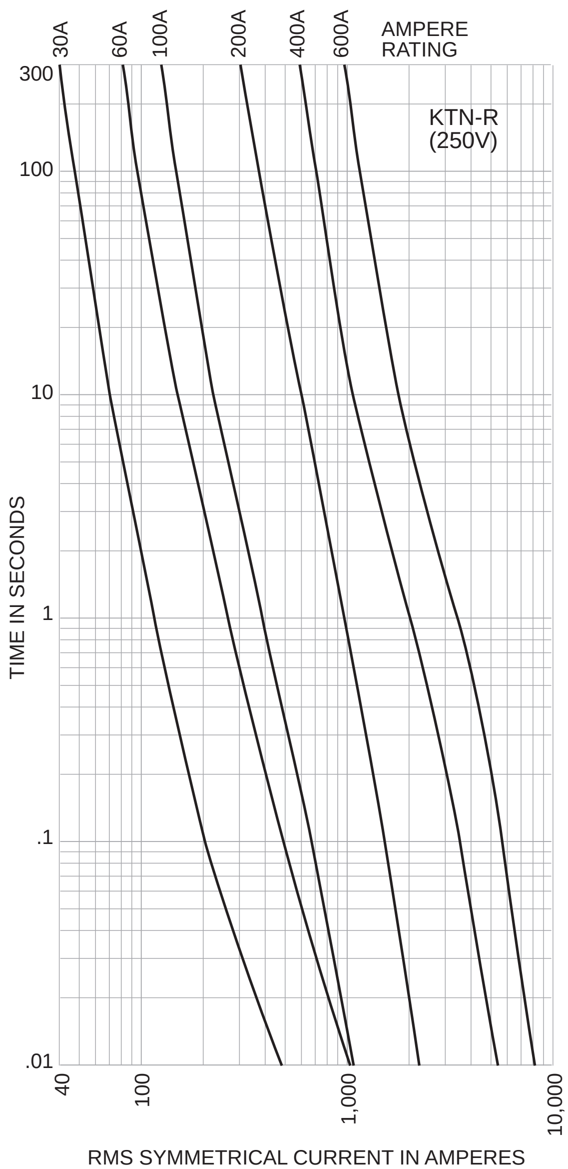


Current Limitation Curves

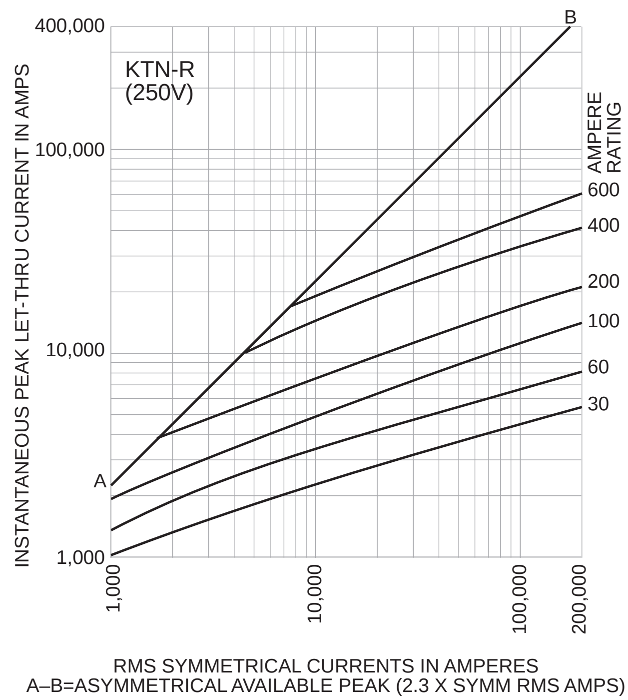


KTN-R (250V) Class RK1 Fuses

Time-Current Characteristic Curves—Average Melt

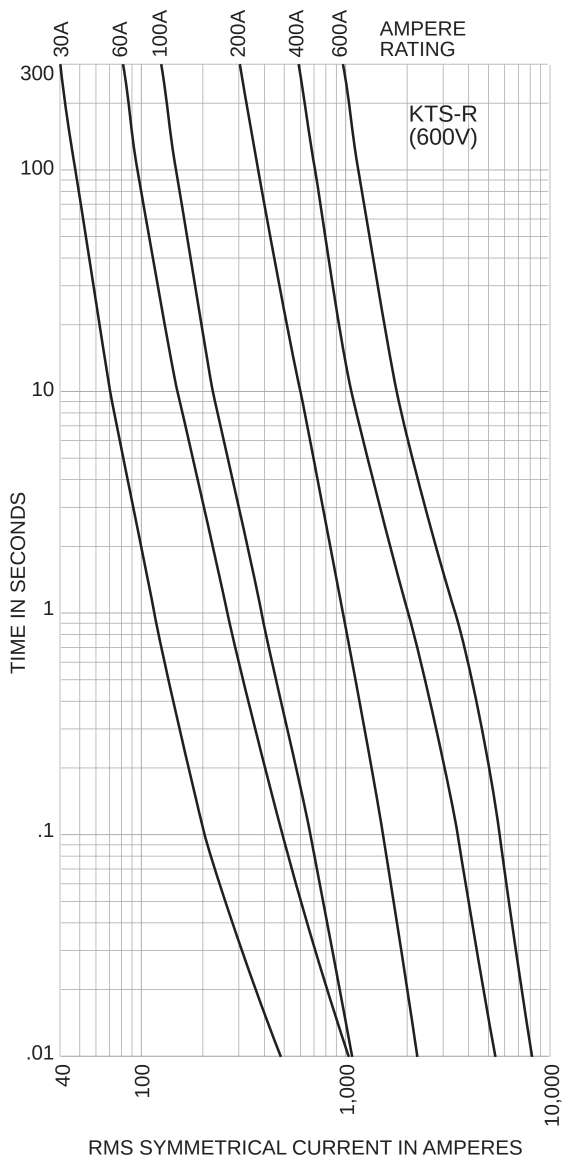


Current Limitation Curves

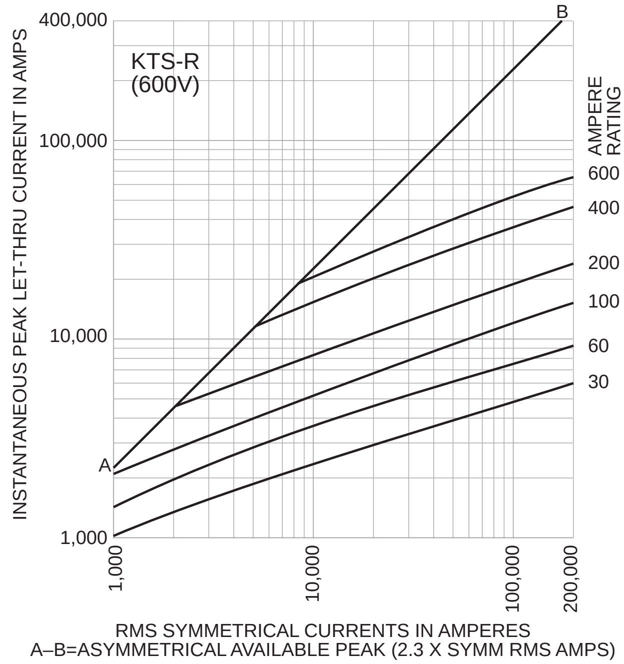


KTS-R (600V) Class RK1 Fuses

Time-Current Characteristic Curves—Average Melt

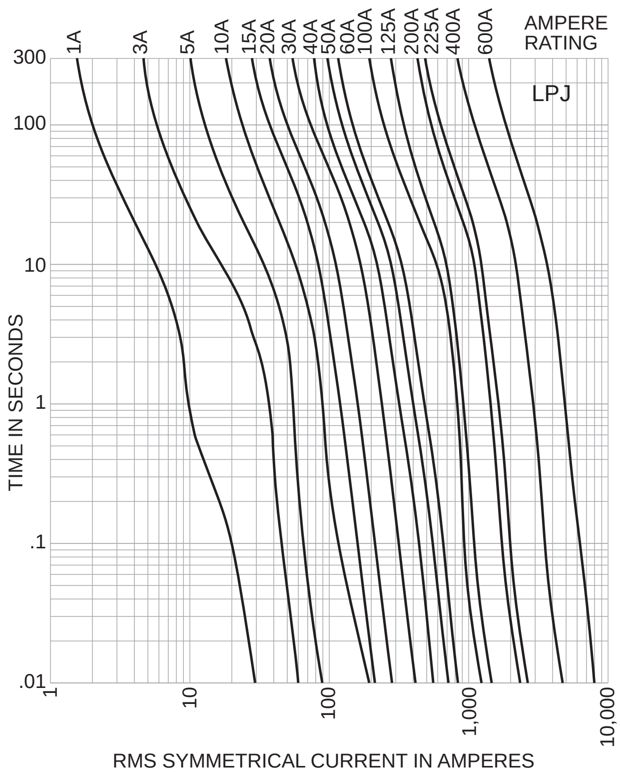


Current Limitation Curves

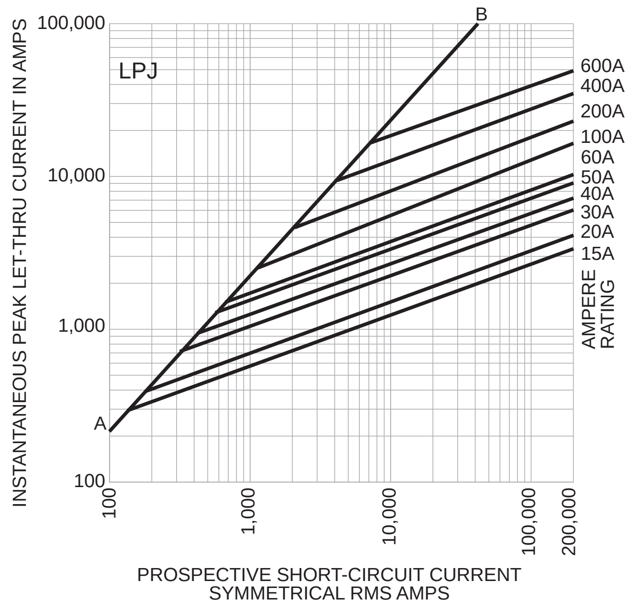


LPJ (600V), Class J Fuses

Time-Current Characteristic Curves—Average Melt

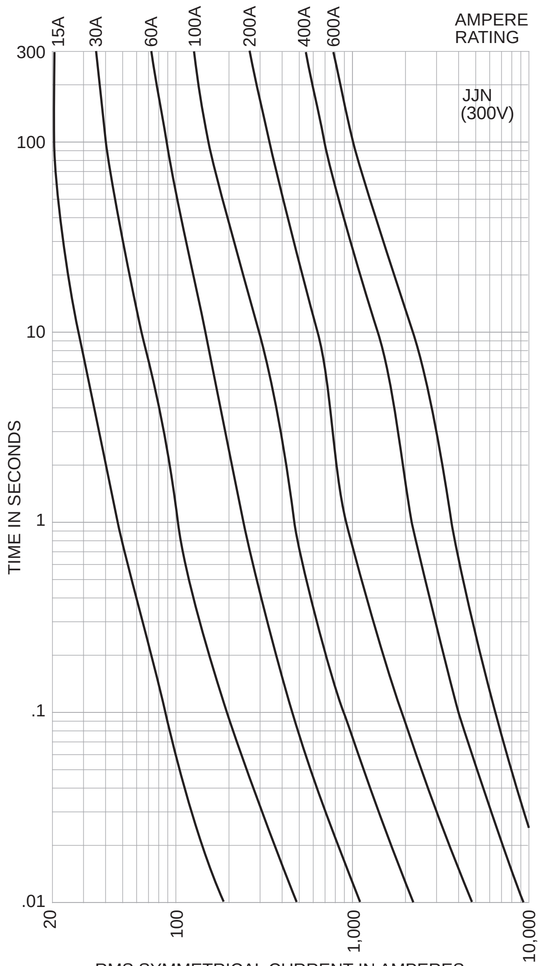


Current Limitation Curves

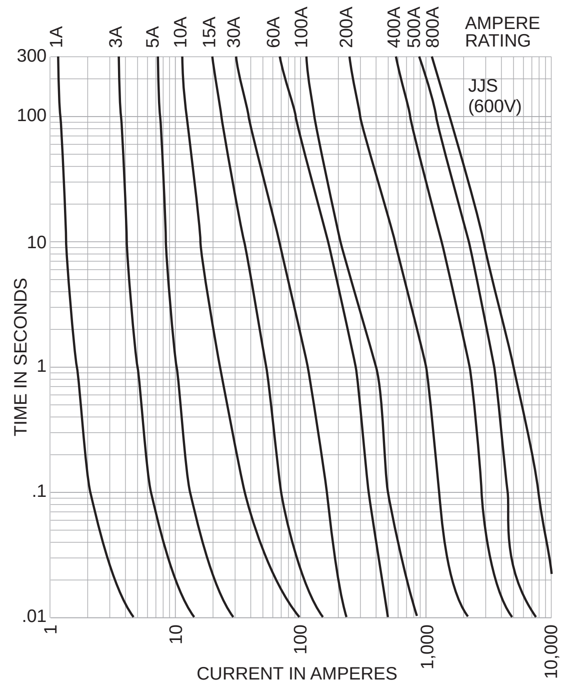


JJN & JJS, Class T Fuses

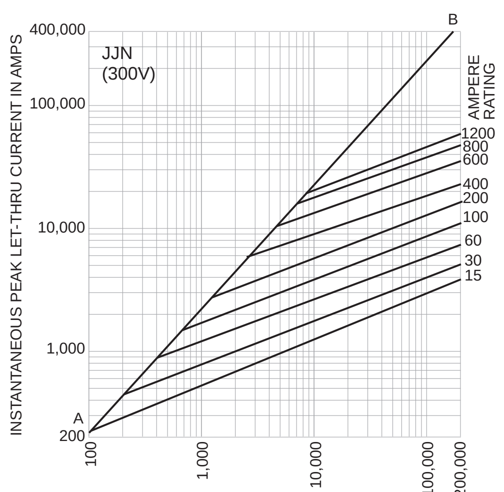
Time-Current Characteristic Curves—Average Melt



Time-Current Characteristic Curves—Average Melt

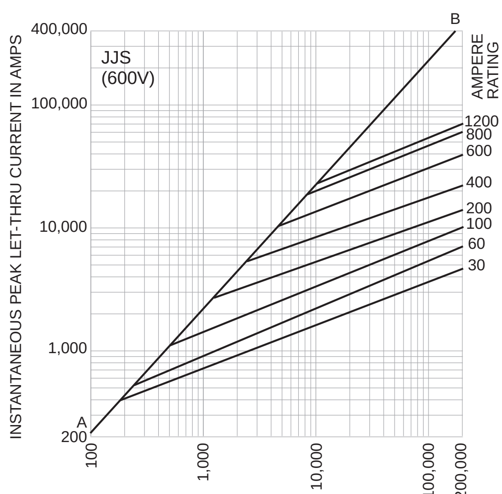


Current Limitation Curves



RMS SYMMETRICAL CURRENTS IN AMPERES
A-B = ASYMMETRICAL AVAILABLE PEAK (2.3 x SYMM RMS AMPS)

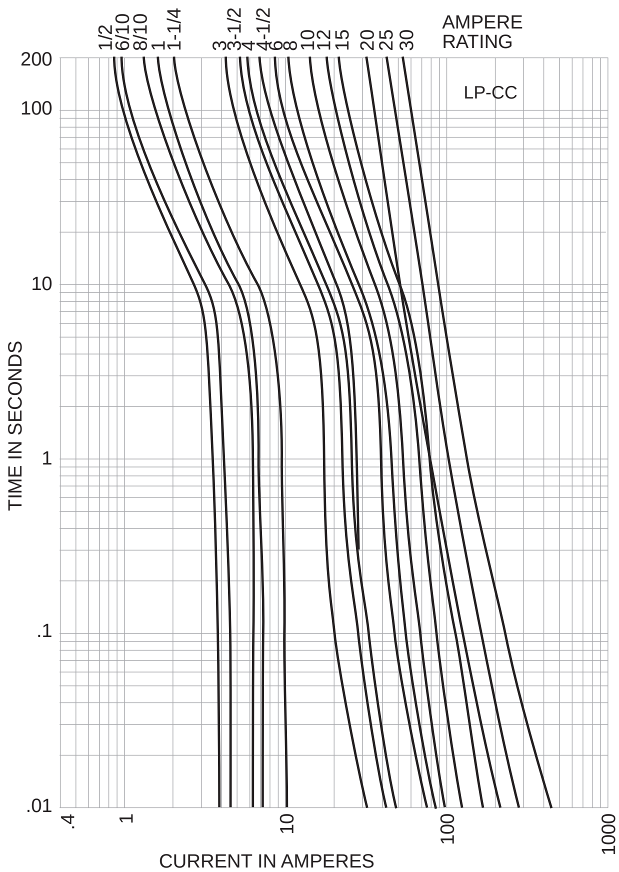
Current Limitation Curves



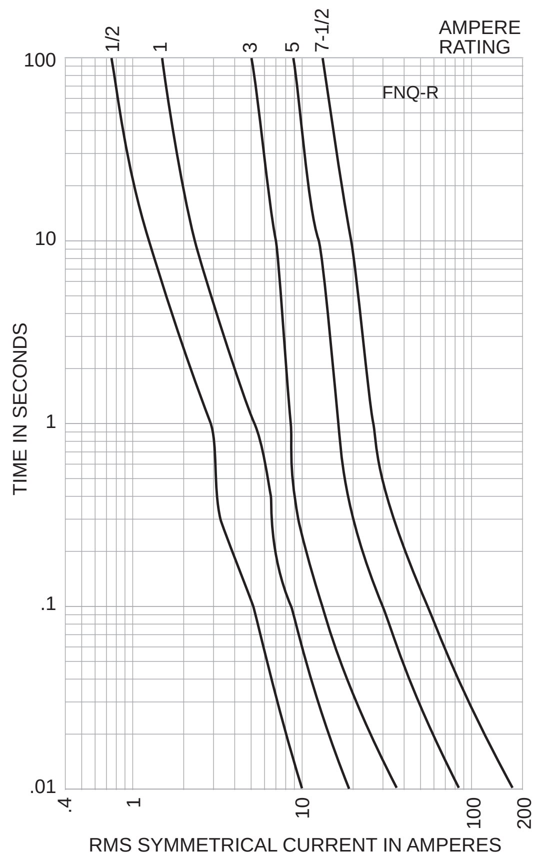
RMS SYMMETRICAL CURRENTS IN AMPERES
A–B=ASYMMETRICAL AVAILABLE PEAK (2.3 X SYMM RMS AMPS)

LP-CC & FNQ-R Class CC Fuses

Time-Current Characteristic Curves—Average Melt

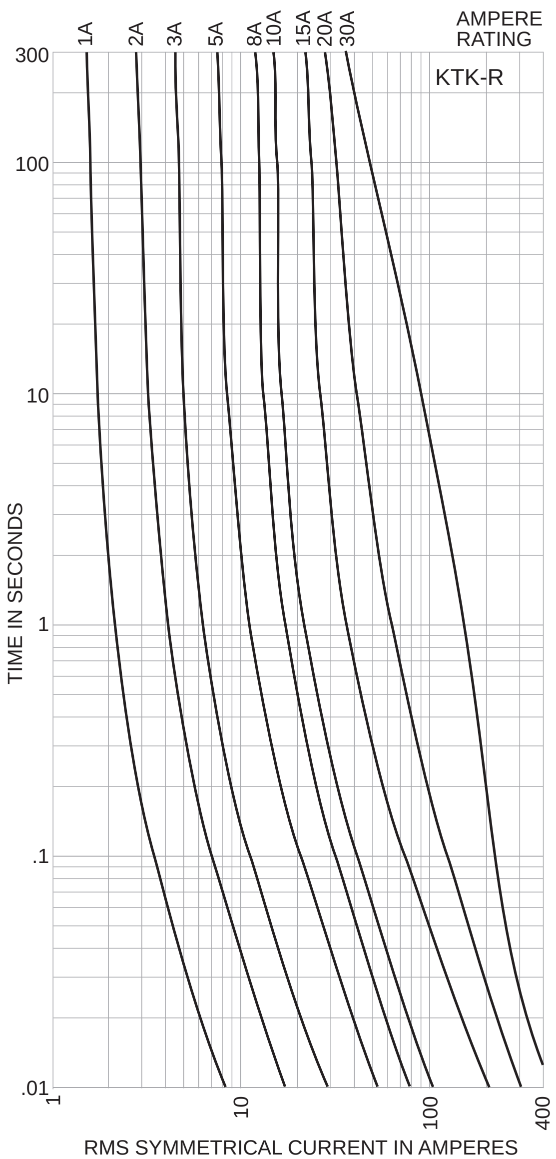


Time-Current Characteristic Curves—Average Melt



KTK-R, Class CC Fuses

Time-Current Characteristic Curves—Average Melt



Ampere
The measurement of intensity of rate of flow of electrons in an electric circuit. An ampere is the amount of current that will flow through a resistance of one ohm under a pressure of one volt.

Ampere Rating
The current-carrying capacity of a fuse. When a fuse is subjected to a current above its ampere rating, it will open the circuit after a predetermined period of time.

Ampere Squared Seconds, I^2t
The measure of heat energy developed within a circuit during the fuse's clearing. It can be expressed as "melting I^2t", "arcing I^2t" or the sum of them as "Clearing I^2t". "I" stands for effective let-through current (RMS), which is squared, and "t" stands for time of opening, in seconds.

Arcing Time
The amount of time from the instant the fuse link has melted until the overcurrent is interrupted, or cleared.

Breaking Capacity
(See Interrupting Rating)

Cartridge Fuse
A fuse consisting of a current responsive element inside a fuse tube with terminals on both ends.

Class CC Fuses
600V, 200,000 ampere interrupting rating, branch circuit fuses with overall dimensions of 13⁄32″ × 1½″. Their design incorporates a rejection feature that allows them to be inserted into rejection fuse holders and fuse blocks that reject all lower voltage, lower interrupting rating 13⁄32″ × 1½″ fuses. They are available from 1⁄10 amp through 30 amps.

Class G Fuses
480V, 100,000 ampere interrupting rating branch circuit fuses that are size rejecting to eliminate overfusing. The fuse diameter is 13⁄32″ while the length varies from 1 5⁄16″ to 2¼″. These are available in ratings from 1 amp through 60 amps.

Class H Fuses
250V and 600V, 10,000 ampere interrupting rating branch circuit fuses that may be renewable or non-renewable. These are available in ampere ratings of 1 amp through 600 amps.

Class J Fuses
These fuses are rated to interrupt a minimum of 200,000 amperes AC. They are labelled as "Current-Limiting", are rated for 600 volts AC, and are not interchangeable with other classes.

Class K Fuses
These are fuses listed as K-1, K-5, or K-9 fuses. Each subclass has designated I^2t and I_p maximums. These are dimensionally the same as Class H fuses, and they can have interrupting ratings of 50,000, 100,000, or 200,000 amps. These fuses are current-limiting. However, they are not marked "current-limiting" on their label since they do not have a rejection feature.

Class L Fuses
These fuses are rated for 601 through 6000 amperes, and are rated to interrupt a minimum of 200,000 amperes AC. They are labelled "Current-Limiting" and are rated for 600 volts AC. They are intended to be bolted into their mountings and are not normally used in clips. Some Class L fuses have designed in time-delay features for all purpose use.

Class R Fuses
These are high performance fuses rated 1⁄10-600 amps in 250 volt and 600 volt ratings. All are marked "Current Limiting" on their label and all have a minimum of 200,000 amp interrupting rating. They have identical outline dimensions with the Class H fuses but have a rejection feature which prevents the user from mounting a fuse of lesser capabilities (lower interrupting capacity) when used with special Class R Clips. Class R fuses will fit into either rejection or non-rejection clips.

Class T Fuses
An industry class of fuses in 300 volt and 600 volt ratings from 1 amp through 1200 amps. They are physically very small and can be applied where space is at a premium. They are fast acting and time-lag fuses, with an interrupting rating of 200,000 amps RMS.

Classes of Fuses
The industry has developed basic physical specifications and electrical performance requirements for fuses with voltage ratings of 600 volts or less. These are known as standards. If a type of fuse meets the requirements of a standard, it can fall into that class. Typical classes are K, RK1, RK5, G, L, H, T, CC, and J.

Clearing Time
The total time between the beginning of the overcurrent and the final opening of the circuit at rated voltage by an overcurrent protective device. Clearing time is the total of the melting time and the arcing time.

Current Limitation
A fuse operation relating to short circuits only. When a fuse operates in its current-limiting range, it will clear a short circuit in less than ½ cycle. Also, it will limit the instantaneous peak let-through current to a value substantially less than that obtainable in the same circuit if that fuse were replaced with a solid conductor of equal impedance.

Dual Element Fuse
Fuse with a special design that utilizes two individual elements in series inside the fuse tube. One element, the spring actuated trigger assembly, operates on overloads up to 5-6 times the fuse current rating. The other element, the short circuit section, operates on short circuits up to their interrupting rating.

Electrical Load
That part of the electrical system which actually uses the energy or does the work required.

Fast Acting Fuse
A fuse which opens on overload and short circuits very quickly. This type of fuse is not designed to withstand temporary overload currents associated with some electrical loads.

Fuse
An overcurrent protective device with a fusible link that operates and opens the circuit on an overcurrent condition.

High Speed Fuses
Fuses with no intentional time-delay in the overload range and designed to open as quickly as possible in the short-circuit range. These fuses are often used to protect solid-state devices.

Inductive Load
An electrical load which pulls a large amount of current—an inrush current—when first energized. After a few cycles or seconds the current "settles down" to the full-load running current.

Interrupting Capacity
See Interrupting Rating

Interrupting Rating
(Breaking Capacity)
The rating which defines a fuse's ability to *safely* interrupt and clear short circuits. This rating is much greater than the ampere rating of a fuse. The NEC® defines Interrupting Rating as "The highest current at rated voltage that an overcurrent protective device is intended to interrupt under standard test conditions."

Melting Time
The amount of time required to melt the fuse link during a specified overcurrent. (See Arcing Time and Clearing Time.)

"NEC" Dimensions
These are dimensions once referenced in the National Electrical Code. They are common to Class H and K fuses and provide interchangeability between manufacturers for fuses and fusible equipment of given ampere and voltage ratings.

Ohm
The unit of measure for electric resistance. An ohm is the amount of resistance that will allow one ampere to flow under a pressure of one volt.

Ohm's Law
The relationship between voltage, current, and resistance, expressed by the equation E = IR, where E is the voltage in volts, I is the current in amperes, and R is the resistance in ohms.

One Time Fuses
Generic term used to describe a Class H nonrenewable cartridge fuse, with a single element.

Overcurrent
A condition which exists on an electrical circuit when the normal load current is exceeded. Overcurrents take on two separate characteristics—overloads and short circuits.

Overload
Can be classified as an overcurrent which exceeds the normal full load current of a circuit. Also characteristic of this type of overcurrent is that it does not leave the normal current carrying path of the circuit—that is, it flows from the source, through the conductors, through the load, back through the conductors, to the source again.

Peak Let-Through Current, Ip
The instantaneous value of peak current let-through by a current-limiting fuse, when it operates in its current-limiting range.

Renewable Fuse (600V & below)
A fuse in which the element, typically a zinc link, may be replaced after the fuse has opened, and then reused. Renewable fuses are made to Class H standards.

Resistive Load
An electrical load which is characteristic of not having any significant inrush current. When a resistive load is energized, the current rises instantly to its steady-state value, without first rising to a higher value.

R.M.S. Current
The R.M.S. (root-mean-square) value of any periodic current is equal to the value of the direct current which, flowing through a resistance, produces the same heating effect in the resistance as the periodic current does.

Semiconductor Fuses
Fuses used to protect solid-state devices. See "High Speed Fuses".

Short Circuit
Can be classified as an overcurrent which exceeds the normal full load current of a circuit by a factor many times (tens, hundreds or thousands greater). Also characteristic of this type of overcurrent is that it leaves the normal current carrying path of the circuit—it takes a "short cut" around the load and back to the source.

Short-Circuit Rating
The maximum short-circuit current an electrical component can sustain without the occurrence of excessive damage when protected with an overcurrent protective device.

Short-Circuit Withstand Rating
Same definition as short-circuit rating.

Single Phasing
That condition which occurs when one phase of a three phase system opens, either in a low voltage (secondary) or high voltage (primary) distribution system. Primary or secondary single phasing can be caused by any number of events. This condition results in unbalanced currents in polyphase motors and unless protective measures are taken, causes overheating and failure.

Threshold Current
The symmetrical RMS available current at the threshold of the current-limiting range, where the fuse becomes current-limiting when tested to the industry standard. This value can be read off of a peak let-through chart where the fuse curve intersects the A-B line. A threshold ratio is the relationship of the threshold current to the fuse's continuous current rating.

Time-Delay Fuse
A fuse with a built-in delay that allows temporary and harmless inrush currents to pass without opening, but is so designed to open on sustained overloads and short circuits.

Voltage Rating
The maximum open circuit voltage in which a fuse can be used, yet safely interrupt an overcurrent. Exceeding the voltage rating of a fuse impairs its ability to clear an overload or short circuit safely.

Withstand Rating
The maximum current that an unprotected electrical component can sustain for a specified period of time without the occurrence of extensive damage.